AQUATIC INVASIVE SPECIES ANNEX

OVERVIEW

Aquatic invasive species (AIS) currently in the Great Lakes are undermining efforts to restore and protect ecosystem integrity and water quality. These organisms have re-engineered the Great Lakes, the way nutrients and chemical contaminants move within the ecosystem, affecting the productivity of the lakes and disrupting integrity of food webs. These ecological effects of AIS have resulted in significant socio-economic impacts on the Canadians and Americans whom depend on the Great Lakes.

New potential invaders, such as Asian carps, threaten to further disrupt the integrity of Great Lakes ecosystems.

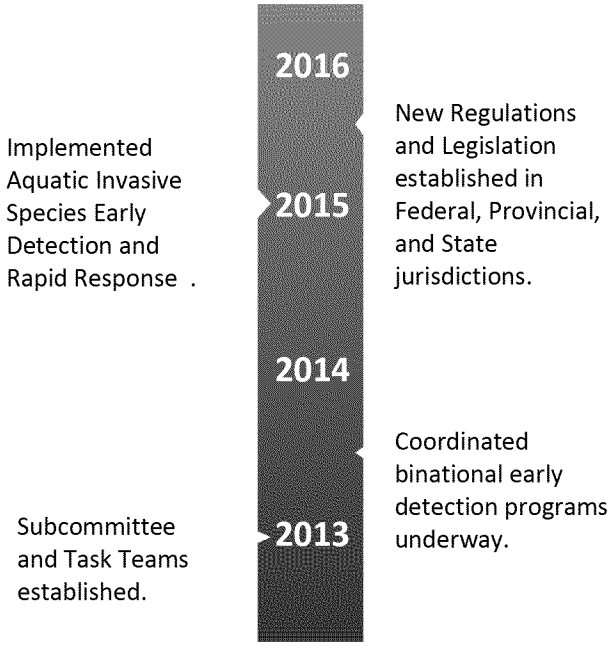
After invasive species become established in the Great Lakes, they are costly to control and nearly impossible to eradicate. Consequently, prevention is the most effective approach to dealing with these threats. The 2012 GLWQA commits the United States and Canada to: 1) preventing the introduction of AIS; 2) controlling or reducing the spread of existing AIS; and 3) eradicating, where feasible, existing AIS within the ecosystem.

The United States and Canada are working to identify and minimize the risk of Asian carps and other species invading the Great Lakes using a risk-assessment approach to better understand the risks posed by species and pathways and by implementing actions to manage those risks. Through efforts of federal, state, and provincial agencies, Canada and the United States have developed and implemented an early detection and rapid response initiative with the goal of finding new invaders and preventing them from establishing self-sustaining populations. This basin-wide effort resulted in several new detections of Grass Carp that triggered coordinated rapid responses by all involved agencies.

Coordinated actions have had significant success! As described, in the previous chapter about *Discharges from Vessels*, United States and Canadian regulations requiring ships to exchange their ballast water with salt water from the open ocean and a coordinated program of monitoring compliance of 100% of ships entering the St. Lawrence Seaway, no new invaders have been introduced by ships since 2006 (see Figure x). Only one new invader has been recorded since 2006 – the aquatic plant called Water Soldier, an ornamental plant used in water gardens and aquariums, which was found in the Trent Severn Waterway during 2008. The efforts undertaken since the inception of the 2012 GLWQA have contributed to the continuing success of no new AIS being known to have become established in the Great Lakes.

The threat of new AIS is ever present and, in spite of this success, continued and new actions are critical. For example, the recently detected evidence of Grass Carp reproduction in the Sandusky River, a tributary to Lake Erie in north-central Ohio in the United States, is of great concern. The United States and Canada are committed to further improving and strengthening the AIS actions and initiatives under the Aquatic Invasive Species Annex.

PROGRESS TOWARD MEETING GLWQA COMMITMENTS



This Annex is being implemented by the Aquatic Invasive Species (AIS) Annex Subcommittee, co-led by the United States Fish and Wildlife Service and Fisheries and Oceans Canada. The AIS Annex Subcommittee delivers its work in close cooperation with the Great Lakes Panel on Aquatic Nuisance Species, which is supported by the Great Lakes Commission and is partially funded by the United States Fish and Wildlife Service. Organizations on the subcommittee include:

BINATIONAL ACTIONS TAKEN

Conducting risk assessments on Aquatic Invasive Species for their entry into the Great Lakes.

- The United States and Canada undertook a review of existing species risks assessments, in coordination with Great Lakes jurisdictions and their partners. Based on this analysis, a binational assessment of the ecological risks and impacts related to Grass Carp establishment was completed, and is being peer reviewed. A similar binational risk assessment is being completed for Black Carp, currently known to occur in the middle Mississippi River and the last of the four Asian carp species

that potentially threatens the Great Lakes.

- In 2013, the Conference of Great Lakes and St. Lawrence Governors and Premiers established a list of 16 "least wanted" species for the Great Lakes, based on a review of risk assessments by their Aquatic Invasive Species Task Group.

- Members of the Aquatic Invasive Species Annex Subcommittee are supporting work of the Conference of Great Lakes and St. Lawrence Governors and Premiers Aquatic Invasive Species Task Group to harmonize approaches to address aquatic invasive species across the basin with a focus on species risk assessments.

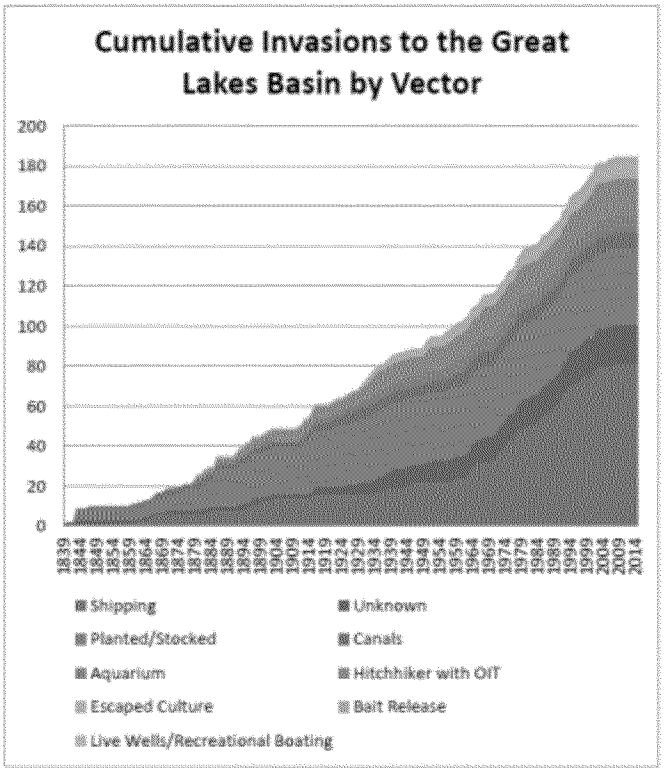
- A risk analysis of illegal trade and transport into Great Lakes jurisdictions was completed and a report of these findings was delivered to the Great Lakes Fishery Commission's binational Law Enforcement Committee. The report recommends risk management efforts to address the unacceptable risks documented for species regulated by state, provincial, and federal agencies in the internet, live bait, live food, aquaculture, private pond/lake stocking, water garden, aquarium/pet, and cultural release pathways. The AIS Subcommittee will continue to work with the Law Enforcement Committee to address risk management needs described in the risk analysis report.

- A new web-based tool called, *Great Lakes Detector of Invasive Aquatics in Trade*, has been developed by the Great Lakes Commission to better quantify the threat posed by the internet commerce pathway. The tool is available to managers in the United States and Canada to inform and help target risk assessment, monitoring and surveillance, and enforcement of aquatic invasive species available for purchase on the internet.

- In the United States, a government-industry partnership is working toward development of new United States recreational boat design standards for building new "AIS-Safe Boats," and development of United States standards for AIS removal from existing recreational boats.

- In Canada, a National Recreational Boating Risk Assessment, with focus on the potential movement of AIS within Canadian and United States waters of the Great Lakes, was carried out during 2015, and the products of this assessment will assist in identifying areas to focus on minimizing risk of recreational boaters spreading AIS.

Figure x - Joint United States and Canada ballast water exchange management success in preventing invaders

Historically, an average of one non-native species was found to be established in the Great Lakes about every 8 months. Most of those introductions resulted from ballast water discharge. No ballast-mediated introductions, and no additional introductions from other pathways, have resulted in establishment of a non-native species since 2008. The success of joint United States and Canada ballast water exchange management has been a major contributor, with no new introductions attributable to ships since 2006.	 *Source R. Sturtevant, GLANSIS-NOAA*

Undertaking outreach and engagement in support of meeting various annex commitments.

- While most outreach and engagement efforts are implemented domestically, experts from government agencies and non-government groups are working across jurisdictional lines to share resources and approaches that modify human behavior so as to minimize risk of people spreading AIS.

- To support this work, the binational Great Lakes Panel on Aquatic Nuisance Species' Information and Education Committee developed a synthesis of communication and education campaigns, programs, and products, which support prevention efforts for a variety of pathways, including recreational boating.

By 2015, develop and implement an Aquatic Invasive Species early detection and rapid response initiative.

- The United States and Canada developed an AIS early detection and rapid response initiative which included a number of strategies to prevent the introduction and spread of AIS. Early detection and rapid response provide a strong second line of defense to augment species prevention efforts by quickly finding AIS populations, including Asian carps, while they are still contained within relatively

small areas and preventing them from becoming established. These efforts mark the first basin-wide early detection network in the history of the Great Lakes, an effort that will be strengthened and enhanced in the future. A full account of the achievements to date under the initiative is available at www.binational.net (http://binational.net/2015/02/23/ais-early-detection/).

- Key components of the AIS early detection and rapid response initiative include:
  - An "AIS species watch list" of those species of the highest priority and likelihood of risk of invading the Great Lakes.
  - A list of priority locations to undertake surveillance for the potential introduction of species on the "AIS species watch list";
  - Protocols for systematically conducting monitoring and surveillance methodologies (such as sampling for environmental DNA (i.e. "free" DNA found in water) and sampling using gears that collect fishes and bottom-dwelling invertebrates) so that a potential invader is promptly observed and reported;
  - The sharing of relevant information amongst the responsible departments and agencies to ensure prompt detection of invaders and prompt coordinated actions to respond to them; and
  - The coordination of plans and preparations for any response actions necessary to prevent the establishment of newly detected AIS.

- The Conference of Great Lakes and St. Lawrence Governors and Premiers provided critical leadership with the establishment of a Mutual Aid Agreement to empower the states and provinces to work collaboratively and to share resources and expertise to deal with AIS that pose a regional threat.

Implementing early detection and rapid response.

- Binational early detection and rapid response for Asian carps have been a focus for Canada and the United States. The Asian carp actions include: establishing priority locations for potential invasion guided by risk assessments; sharing protocols for early detection monitoring; coordinated communication protocols; and coordinated response planning.

- Detections of Grass Carp in Canadian waters triggered fully coordinated implementation of response plans under the incident command system. Those successful responses provided real-world testing of the Canadian domestic response framework.

- On Lake Superior, a binational early detection program has been implemented by the United States federal, state, and tribal agencies and the province of Ontario. This coordinated effort has benefited from a performance evaluation of early detection monitoring surveillance programs which revealed new opportunities to substantially increase the speed and sensitivity of detecting newly-introduced species. By focusing efforts on areas within ports known to carry rare and invasive species, and by increasing the use of sampling equipment that captures a wide diversity of organisms, the effectiveness at detecting invasive species has nearly doubled. To continue improvement in the future, the United States Environmental Protection Agency, the United States Fish and Wildlife Service, and their partners, have implemented an adaptive management approach using a cycle of review and ongoing refinement of the surveillance program.

Conducting research to develop and test Aquatic Invasive Species detection, containment, and control technologies.

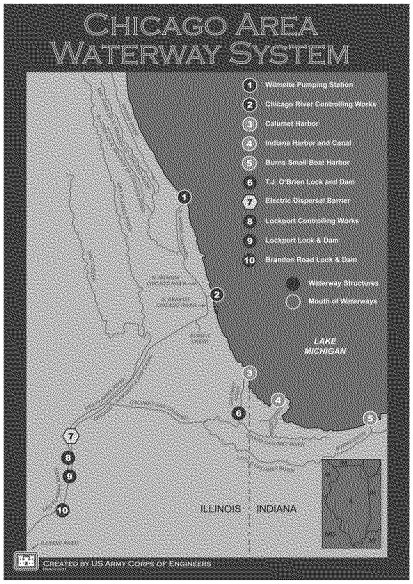
- The Asian Carp Regional Coordinating Committee provides a forum for coordination of new research about how to detect, control or contain Asian carps. The critical exchange of science ensures that research in the United States and in Canada is complementary and synergistic.

- The Great Lakes Fishery Commission, working with the UNITED STATES Geological Survey, United States Fish and Wildlfe Service, and Fisheries and Oceans Canada, delivers an ongoing binational research effort to find new ways to control Sea Lampreys and to improve the methods that are used today. An example of a new tool is the Sea Lamprey mating pheromone, 3kPZS, which was official registered in the United States and Canada as the first ever vertebrate pheromone biopesticide. Like an alluring perfume, the mating pheromone is a scent released by male Sea Lampreys to lure females onto nesting sites. The mating pheromone has been used as bait in traps that collect and remove adult Sea Lampreys before they have a chance to spawn. Research and development of the mating pheromone was funded by the Great Lakes Fishery Commission, with additional support from the Great Lakes Restoration Initiative, in collaboration with federal governments, university, and private industry partners.

Figure x – Battling Asian Carp Together

The Asian Carp Regional Coordinating Committee (ACRCC) was formed in 2009 to address the growing threat from established and expanding populations of Asian carps in the Mississippi	

River basin with the focus on Great Lakes protection. The ACRCC, co-chaired by the United States. Environmental Protection Agency and United States Fish and Wildlife Service, has grown to a bi-national partnership of 27 United States and Canadian federal, state, provincial, and local government agencies working in coordination to prevent the introduction, establishment, and spread of Bighead, Black, Grass, and Silver carp populations in the Great Lakes. The ACRCC has developed a comprehensive, multi-pronged approach, heavily focused on prevention and control opportunities in the Illinois Waterway and Chicago Area Waterway System as the primary potential pathway for dispersal toward the Great Lakes; basin-wide, bi-national surveillance and early detection for Asian carp; and assessment and closure of secondary pathways of potential introduction in Indiana and Ohio, as indicated in the Great Lakes and Mississippi River Interbasin Study (GLMRIS). The ACRCC approach, embodied in its annual strategy, the Asian Carp Action Plan (Action Plan) (http://www.asiancarp.us/documents/2016AsianCarpActionPlan.pdf), has evolved to include progressively more aggressive Asian carp management through targeted removal of Bighead and Silver carp in upstream locations in the Illinois Waterway; development of increasingly advanced genetics-based early detection technologies for use in basin-wide monitoring; use of risk assessment to inform the implementation of key management projects (e.g. to achieve GLMRIS pathway closures, and to guide Grass Carp surveillance in Canadian waters) and studies of additional possible pathways of introduction, including potential entrainment and transit of small fish in barges; the identification and development of new potential control tools and integrated pest management strategies; and comprehensive communications on Asian carp developments with policy makers, partners and stakeholders in the United States and Canada. While a key component in the strategy for Great Lakes defense remains the operation and expansion of the Corps of Engineers' electric dispersal barrier system near Chicago, the Action Plan has evolved to include a holistic portfolio of over 60 projects being implemented by member agencies, supported through federal, state and provincial agency base funds and the Great Lakes Restoration Initiative. The Action Plan is complemented by the partnership's annual Monitoring and Response Plan (http://www.asiancarp.us/documents/MRP2016.pdf), the tactical plan that prescribes the specific time, location, and duration of the many coordinated agency monitoring and control actions conducted throughout the year. The 2016 Monitoring and Response Plan includes new contingency for "emergency response" plans that provide specific recommendations of "shelf-ready" rapid-response control options currently available for use by the State and Federal response agencies in the event the upstream movement of any life stage of Asian carp is detected above a pre-determined threshold in key upstream navigation pools in the Illinois Waterway and the Chicago Area Waterway System. The primary focus of the contingency plans is on actions for defending navigation pools in the Illinois Waterway immediately downstream of the Brandon Road Lock and Dam. The ACRCC continues to strategically contain established populations of Asian carps below that lock and dam to prevent Asian carp population establishment in the Great Lakes. Additional information on the ACRCC partnership's bi-national efforts can be found at www.asiancarp.us and www.asiancarp.ca.



DOMESTIC ACTIONS TAKEN

Conducting risk assessments on Aquatic Invasive Species for their entry into the Great Lakes.

- Approximately 160 risk assessments were conducted by the United States on non-native species and published on www.fws.gov (http://www.fws.gov/fisheries/ANS/species_erss_reports.html) These risk assessments have identified high risk fish, crustaceans, and mollusks that thrive in climates similar to the Great Lakes Basin and could become established if they are introduced in large enough numbers.

- The risk of barge shipping-related inadvertent entrainment and transport of small fishes within the Chicago Area Waterway System was evaluated, and the resulting report delivered to the Asian Carp Regional Coordinating Committee, industry, and the public. Results indicate that small free-swimming fish, including surrogate fish placed in and around barges by researchers and wild fish, can become trapped and remain between barges for substantial distances. In one trial, live fish were transported more than nine miles up the Illinois Waterway and Chicago Area Waterway System, travelling progressively upstream through the Brandon Road Pool, Lockport Lock, and, finally, the United States Army Corps of Engineers' electric dispersal barriers near Chicago. Further studies on the susceptibility of actual small (juvenile) Asian carps to becoming entrained and transported under realistic conditions, methods to clear all fish from these barge-to-barge junction spaces, and improvements in barge operation best management practices to minimize likelihood of entrainment are being pursued to reduce this risk.

Preventing introduction and spread of Aquatic Invasive Species through regulations.

- Based on risk assessments and supporting science, the state of Michigan amended its prohibited species list in regulation to include several new invasive species. Additional information can be found at: http://www.michigan.gov/invasives/0,5664,7-324-68071---,00.html.

- Similarly, the State of New York has recently amended their regulations, effective March 2015, to prohibit species to affect more control of the risk of new invaders. Additional information can be found at http://www.dec.ny.gov/animals/99141.html.

- The United States Fish and Wildlife Service has proposed adding 11 non-native freshwater species to the list of injurious species under the Lacey act. Ten fishes (Crucian Carp, Eurasian Minnow, Prussian Carp, Roach, Stone Moroko, Nile Perch, Amur Sleeper, European Perch, Zander, Wels Catfish) and one crayfish (common yabby) are included in the proposed rulemaking. A final rule is planned for release in 2016.

Implementing early detection and rapid response.

- Great Lakes states have been actively monitoring and responding to detections of invasive species, including recent response actions following detection of invasive Water lettuce, New Zealand Mudsnail, Parrot Feather, Red Swamp Crayfish, Water Hyacinth, Water Chestnut, European Frogbit, Starry Stonewort, Northern Snakehead, and small killifish (Mummichog).

- The invasive species Hydrilla was discovered in the Cayuga Lake Inlet and Erie Canal in central New York. Aggressive eradication projects started at both locations in response to concerns about the spread of this invasive plant species throughout the Great Lakes basin. Despite signs of a successful control, eradication may take several more years due to ability of root systems to lay dormant in the sediment. More information about Hydrilla can be found at http://stophydrillawny.org/.

Conducting research to develop and test Aquatic Invasive Species detection, containment, and control technologies.

- U.S. federal partners carried out development and testing to advance the use of near-real time environmental DNA (eDNA)-based analysis in the field to support law enforcement efforts for effectively detecting and interdicting illegal transport of Asian carp species into Great Lakes jurisdictions (eDNA is the "free" genetic material left behind by an organism and evident in water column).

- United States federal partners continue to evaluate the potential use of carbon dioxide as an environmentally sound approach to help contain or repel Asian carps in strategic confined locations (e.g. lock and dam approach channels, river/embayment confluences) to prevent additional introductions and limit further range expansion.

- Work was initiated in the United States on the development and testing of a system to deliver a piscicide (Antymicin) that can kill Bighead and Silver Carps while not harming other fishes. This technology could be used to reduce populations in the Chicago Area Waterway System and Illinois River, which would further reduce the risk of Asian carps becoming established in the Great Lakes.

- New molecular genetic techniques are being developed for detecting rare invasive species. Current research efforts funded by the Great Lakes Restoration Initiative (GLRI) have focused on: 1) expanding the use of environmental DNA; 2) genetic analyses of larval fish samples to detect the reproduction of invasive fishes; and 3) genetic analyses of lake sediments or benthos for detection of invasive species such as the Zebra Mussel, Quagga Mussel, and New Zealand Mudsnail. The current trend of advancing molecular genetic methods coupled with decreasing costs is highly promising.

- Based on extensive testing, the commercial product "Zequanox" was approved for open-water use to control invasive Zebra and Quagga mussels in lakes and rivers. United States agency and academic partners are exploring its strategic use in the Great lakes and inland lakes. Zequanox is composed of dead cells derived from a naturally occurring soil microbe, and it controls invasive mussels in all life stages. Its active ingredient has low toxicity and presents little risk to non-target

organisms.

- The United States is funding and supporting new methods to control the spread of invasive aquatic plant *Phragmities* including:
    - Research at Cornell University to identify insects that kill *Phragmites*. The researchers are evaluating the host-specificity of each insect species in preparation for wide-spread releases of insects that may help control *Phragmites* populations.
    - Work by the United States Geological Survey and its partners to identify the fungal microbes that help provide nutrients to nonnative *Phragmites*, and work to find ways to slow *Phragmites* growth by disrupting this symbiotic relationship.
    - Work by Wayne State University and United States Geological Survey scientists to silence important genes in *Phragmites* (e.g., those for flowering, seed set, and photosynthesis) in an effort to reduce its competitive advantage. Cooperating scientists are testing gene silencing of photosynthesis in *Phragmites*. The next step will be to test the technology in the field and develop an application method that will be feasible over a large scale.
    - More information about *Phragmities* can be found at http://greatlakesphragmites.net/research/control-options/.

Assessing the potential impacts of climate change on Aquatic Invasive Species.

- A climate change projection tool was developed that can project the AIS climate niche, within the Great Lakes basin, under several climate change scenarios published by the Intergovernmental Panel on Climate Change (http://www.ipcc.ch/) for the years 2050 and 2070.

Conducting risk assessments on Aquatic Invasive Species for their entry into the Great Lakes.

- During 2013, a national risk assessment of ballast water introductions of AIS species was completed with a focus on the Great Lakes and St. Lawrence River. That risk assessment identified the need to reduce risk by incorporating ballast water treatment into systems of ships that discharge ballast into the Great Lakes.

- During 2013, a peer review of available risk assessment tools was carried out, and science advice was published, about screening-level risk assessment protocols for nonindigenous freshwater organisms in trade in Canada that provides guidance to evaluating risks to support prevention actions.

- Ontario Ministry of Natural Resources and Forestry has conducted 14 draft risk assessments for non-native fishes, aquatic invertebrates and plants. The risk assessments will be used in support of regulations under the new Invasive Species Act, 2015.

Preventing introduction and spread of Aquatic Invasive Species through regulations.

- With extensive public and government consultation, Canada established new aquatic invasive species regulations under the Fisheries Act in June 2015 creating new prohibitions for species based on risk and enabling new measures for prevention and control of AIS in Canada and at its borders.

- In November 2014, the Province of Ontario reintroduced the proposed Invasive Species Act, to support the prevention, early detection, rapid response and eradication of invasive species in the province. The Ontario Invasive Species Act, 2015, received Royal Assent on November 3, 2015 and comes into force on November 3, 2016. A risk assessment process will be used to classify species for regulation that pose a threat to Ontario's natural environment, including the Great Lakes.

Implementing early detection and rapid response.

- Canada, working closely with Ontario and United States jurisdictions, has delivered its Asian Carp Program based on four pillars: prevention, early warning, response, and management. The program includes extensive early detection surveillance activities in close conjunction with environmental DNA monitoring carried out by Ontario. More information can be found at http://asiancarp.ca/.

- Canada, in coordination with the Ontario Federation of Anglers and Hunters, the Invasive Species Centre, and Royal Ontario Museum carried out a large-scale outreach campaign specific to raise awareness and public understanding of best practices to prevent the transport and spread of Asian carps.

- The Ontario Federation of Anglers and Hunters, in partnership with Ontario engage the public in citizen science to detect invasive species through the Ontario Invasive Species Awareness Program, reporting hotline, and new tools like the Early Detection and Distribution Mapping System (EDDMaps Ontario) smartphone app.

- Findings of Grass Carp in lakes Erie and Ontario between 2013 and 2015 have triggered successful coordinated response efforts under the incident command system testing the domestic response framework established for Asian carps.

- Extensive efforts continue to respond to the establishment Water Soldier, an invasive aquatic plant, first discovered in 2008 in the Trent Severn Waterway in Ontario. Ontario, Parks Canada, the Ontario Federation of Anglers and Hunters, the Conservation Authority, and other partners are collaborating to prevent further spread, to detect any expansion of the plants range and respond to new findings, and to eradicate the established population through chemical and mechanical control measures.

Conducting research to develop and test Aquatic Invasive Species detection, containment, and control technologies.

- Research has been completed about the capacity for invasive fish species, including Asian carps, to move through the Welland Canal and the St. Mary's River canals to help better understand the risk of spread and opportunities for control.

- Research on repulsion devices, including sound, light, and electricity, to potentially contain and control fish species, including Asian carps, has been carried out using surrogate species in a large-scale mesocosm located in Hamilton Harbour, Lake Ontario.

- Canada continues to actively research monitoring and treatment technologies to advance efforts to prevent AIS movement in the ballast water of ships including evaluation of the current binational ballast water exchange monitoring program, testing of ballast water treatment technologies, and evaluation of sampling methods to support new International Maritime Organization ballast water standards.

- Ontario and Canada are carrying out research to advance the application of environmental DNA for the detection of AIS for Asian carps, Water Soldier, Zebra Mussels, and other species, with refinement to quality control procedures, with refinement of detection sensitivities, and with establishment of new markers.